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Application S/N 15,023
Filed: 02/27/70
Contractor: Caltech/JPL
Contract NAS7-100

AWARDS ABSTRACT

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Contractor: Jet Propulsion Laboratory

LIQUID JUNCTION AND METHOD OF FABRICATING THE SAME

~~The present invention is embodied in~~ a junction element suitable for use as a glass electrode and is fabricated by cracking a glass rod into a plurality of contiguous portions mated along a plane of cleavage and seated in a tubular conduit.

The junction element includes an elongated section of a glass rod 10 which is scored along lines 12 in a manner such that the score lines define opposite boundaries of a plane of cleavage extending transversely through the section. The section 10 is then divided along the plane by applying stress-developing pressures for fracturing the section along the region of the plane. A resulting crack thus is produced dividing the section into diametrically opposed portions. These portions are seated in a tubular glass conduit 20. Heat is applied to the external surfaces of the tubing 20 in the region of the cracked rod section 10 for fusing the periphery of the opposed portions of the section 10 to the internal surfaces of the tube 20. Consequently, a fusion barrier to the passage of fluid between the surface of the wall of the tube 20 and the periphery of the section 10 is achieved. If desired, additional heat may be applied for selectively fusing the portions along the plane of cleavage.

By employing the glass rod cracked along the planes of cleavage, a fluid junction capable of relatively easy and inexpensive fabrication is provided for achieving efficient fluid restriction over periods of extended duration.

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S P E C I F I C A T I O N

TO ALL WHOM IT MAY CONCERN:

BE IT KNOWN THAT STEPHEN P. VANGO, a citizen of the United States of America, residing at Los Angeles, in the County of Los Angeles, State of California, has invented a new and useful

LIQUID JUNCTION AND METHOD
OF FABRICATING THE SAME

of which the following is a specification:

ABSTRACT OF THE DISCLOSURE

ORIGIN OF THE INVENTION

The invention described herein was made in the performance of work under a NASA contract and is subject to the provisions of Section 305 of the National Aeronautics and Space Act of 1958, Public Law 85-568 (72 Stat. 435; 42 U.S.C. 2457).

BACKGROUND OF THE INVENTION

1. Field of the Invention:

The present invention relates to glass articles and their manufacture, and more particularly to a fluid junction suitable, for example, for use as a glass electrode or membrane in pH meters, but generally useful in applications in which a highly restricted fluid flow is to be provided for, and to a method of making such junctions.

A standard device for the measurement of pH is an electrolytic cell incorporating what is known as a "glass electrode" or glass "membrane" disposed between a known solution and the solution the pH of which is to be measured. The principles of such devices are described in the Encyclopedia Britannica, 1963 Edition, Volume 11, pages 981-2.

The glass electrodes or membranes incorporated in such devices are essentially liquid junctions characterized by a high degree of restriction of the liquid flow therethrough, and it is to the improvement of such liquid junctions and a method of making them that the present invention is directed.

2. Description of the Prior Art:

A variety of foraminous elements have been utilized as the glass electrodes of pH meters of the type referred to above. A membrane in the form of the thin wall of a bulb blown with a special glass is described in the publication mentioned above. Ultra-fine filtering elements, such as the capillary tube assembly of Altosaar U.S. patent No. 2,752,731 and the centered glass filter of Poad U.S. patent No. 3,414,394 are likewise capable of being so employed. Such devices are, however, susceptible of becoming plugged by contaminants as well as being difficult and expensive to fabricate.

OBJECTS AND SUMMARY OF THE INVENTION

The device and method of the present invention has as its principal object the provision of a fluid junction capable of relatively easy and inexpensive fabrication, and particularly useful in electrolytic applications such as described above, as well as in applications in which a restricted discharge is to be provided for small quantities of liquids over a long time period, as, for instance, in instrumentation designed for vehicles used in space exploration.

According to the invention, an homogenous section of brittle and relatively chemically inert material, such as a section of glass rod, is scored along lines defining a plane and is then cracked by exerting pressures producing a fracturing stress at the defined plane.

While the crack thus produced will be disposed generally in the defined plane, all portions of the opposite surfaces defining the crack will not be exactly in the same plane, and it will be found that the separated portions of the rod section will fit together well only when realigned in the relative positions which they occupied before cracking.

After cracking, therefore, the separated portions of the rod section are so realigned and maintained in such relative orientation by fitting them within a glass tube having an inside diameter closely matching the outside diameter of the cracked rod section.

Heat is then applied to the tube in the region of the rod sufficient only to fuse the inside wall of the tube with the cylindrical peripheral surface of the cracked rod section at least sufficiently to produce a fusion barrier to the passage of fluid between the inside wall of the tube and the periphery of the cracked rod section without fusing and thus sealing the crack in the rod section.

If, however, it is desired to provide a fluid junction having an even more restricted flow passage, the application of additional heat is effected at the portions of the tube opposite the edges of the crack in the rod section within the tube, thus causing progressive sealing of the crack from the edges inwardly and further restricting the flow passage. The extent of the restriction thus effected is controlled by arresting such heating when the desired degree of restriction has been effected.

These together with other objects and advantages of the present invention will subsequently become more clearly apparent upon reference to the following description in the specification and accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

Fig. 1 is a view in side elevation of a fluid junction embodying the present invention;

Fig. 2 is a view in perspective of the device of Fig. 1 with a portion of the tube wall cut away to disclose the underlying rod section more clearly; and

Fig. 3 is a detail view of the cracked rod section with a part of one portion thereof broken away to more clearly show the surface produced by cracking.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In fabricating a device embodying the present invention, a homogenous section of brittle and relatively chemically inert material, such as glass, generally designated 10 in Fig. 3 of the drawing, is first longitudinally scored along lines 12 preferably at diametrically opposite portions of the periphery of the rod section 10, so that the score lines will define two boundaries of a plane lying within the rod section. This plane defines an intended plane of cleavage for the brittle material.

The portions of the rod section 10 lying on opposite sides of the score lines 12 are then subjected to opposite pressures producing a fracturing stress in the region of the plane defined by the score lines 12, thus cracking the rod section 10 into two portions 14 and 16. While the crack thus produced will be disposed generally in the defined plane, all portions of the opposite surfaces, such as the surface 18 of the portion 16, will not lie exactly in the same plane, and it will be found that the separated portions of the rod section will fit together well only when realigned in the relative positions which they occupied before cracking.

In order to form a liquid junction according to the present invention, therefore, the separated portions 14 and 16 of the rod section 10 are realigned into the same relative positions which they occupied before cracking and are maintained in such realignment by fitting them within a section of tubing 20 the inside diameter of which corresponds sufficiently closely to the outside diameter of the realigned portions 14 and 16 of the rod section 10 to prevent relative displacement thereof; the irregularity of the surface 18 serving to prevent such displacement when the aligned sections 14 and 16 are confined within the tube 20.

Heat is then applied to the tubing 20 in the region of the cracked rod section 10 sufficient to fuse the inside wall of the tube 20 with the cylindrical peripheral surface of the cracked rod section 10 at least sufficiently to produce a fusion barrier to the passage of fluid between the inside wall of the tube 20 and the periphery of the cracked rod section 10 without fusing and thus sealing the crack in the rod section 10. During such heating, the exterior walls of the tube 20 are preferably subjected to slight pressure which may be supplied by rolling the tubing between carbon flats to assure fusion between the glass tube and the rod section.

If, however, it is desired to provide a fluid junction having an even more restricted flow passage than provided by the complete crack between the sections 14 and 16 of the rod section 10, additional heat is applied to the exterior wall of the tubing 20 directly adjacent the meeting line of the sections 14 and 16 within the tube. The application of heat in this manner causes progressive sealing of the crack between the sections 14 and 16 from the edges inwardly, thus further restricting the flow passage. The extent of the restriction thus effected is controlled by arresting such heating when the desired degree of restriction has been effected.

The completed device thus produced is shown in Fig. 1. Fluid entering the tube 20, for example, in the direction indicated by the arrow in Fig. 1, encounters the face of the cracked rod section 10 the periphery of which is fused to the inside wall of the tube 20 so as to constitute a barrier to the passage of fluid between the inside wall of the tube and the periphery of the cracked rod section. Therefore, fluid can pass beyond the cracked rod section 10 only by sweeping in a broad thin film between the portions 14 and 16 of the cracked rod section 10. This film of liquid is, in the case of an electrolyte, sufficiently conductive to render the device useful as a glass electrode or membrane in a pH meter, and in other applications of the device very small volumes of liquid may be fed slowly, as from a reservoir, through the crack between the portions of the cracked rod section 10.

Although the invention has been herein shown and described in what is conceived to be the most practical and preferred embodiment, it is recognized that departures may be made therefrom within the scope of the invention, which is not to be limited to the illustrative details disclosed.

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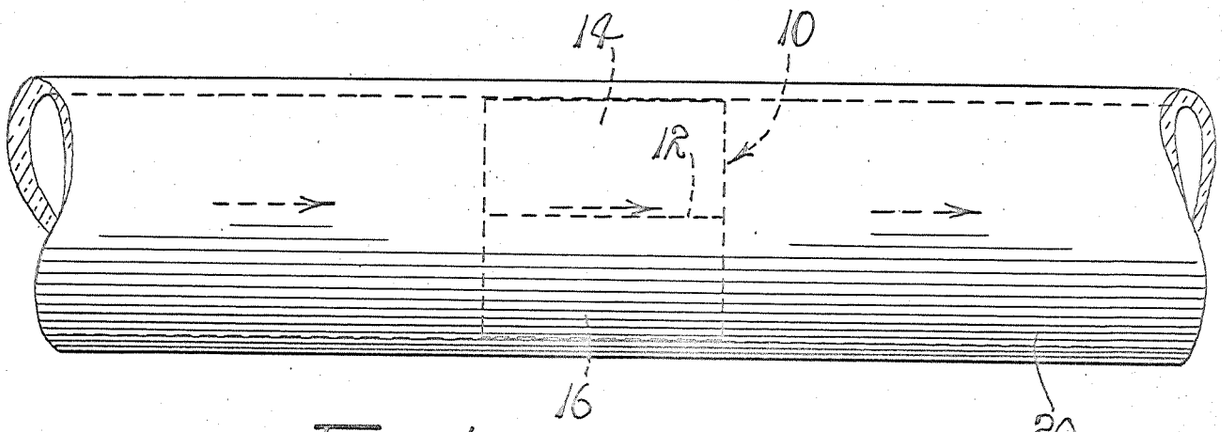

FIG. 1.

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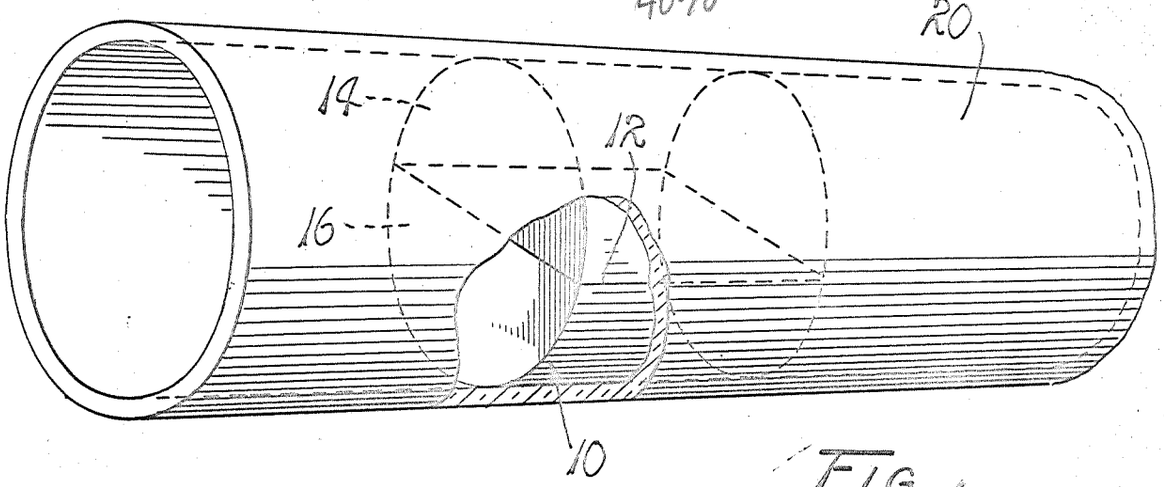

FIG. 1 -

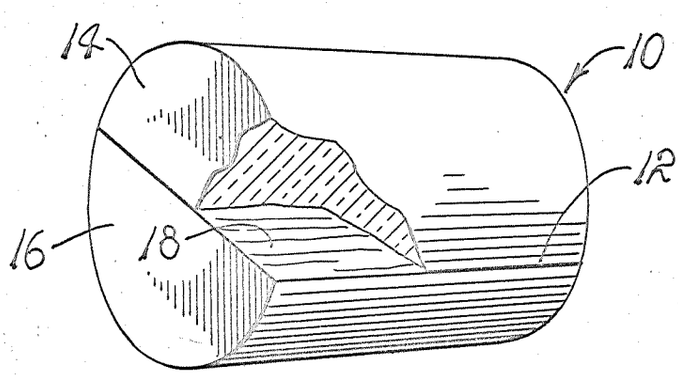

FIG. 3.

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